

50 kHz - 520 MHz
Synthesized Signal Generator
TF 2020

Code No. 52020-301S



1976

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

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PRELIMINARIES

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Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ►.....◄ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.*

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

- * In the absence of a slow-blow fuse of this rating a higher rated, e.g. 13 A, quick blow type may be used.

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of IEC Directive 76/889 as to limits of r.f. interference.

WARNING : HEALTH HAZARD

Beryllia (beryllium oxide) is used in the construction of the following components in this equipment :

Unit AD3 : Transistors TR2 and TR3.

This material, when in the form of fine dust or vapour and inhaled into the lungs, can cause a respiratory disease. In its solid form, as used here, it can be handled quite safely although it is prudent to avoid handling conditions which promote dust formation by surface abrasion.

Because of this hazard you are advised to be very careful in removing and disposing of these components. Do not put them in the general industrial or domestic waste or despatch them by post. They must be separately and securely packed and clearly identified to show the nature of the hazard and then disposed of in a safe manner by an authorized toxic waste contractor.

WARNING : HANDLING HAZARDS

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING : TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol  on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

- (1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.
- (2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

- (3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

Chapter 1

GENERAL INFORMATION

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INTRODUCTION

1. TF 2020 is a synthesized signal generator providing c.w., a.m. and f.m. outputs in the range 50 kHz to 520 MHz. All the main operating functions, carrier frequency, modulation and output, can be controlled either manually by lever type digital switches or remotely by application of programmable b.c.d. commands. It is therefore equally suitable for use as a manually operated bench mounted instrument or as part of a fully automated test system.

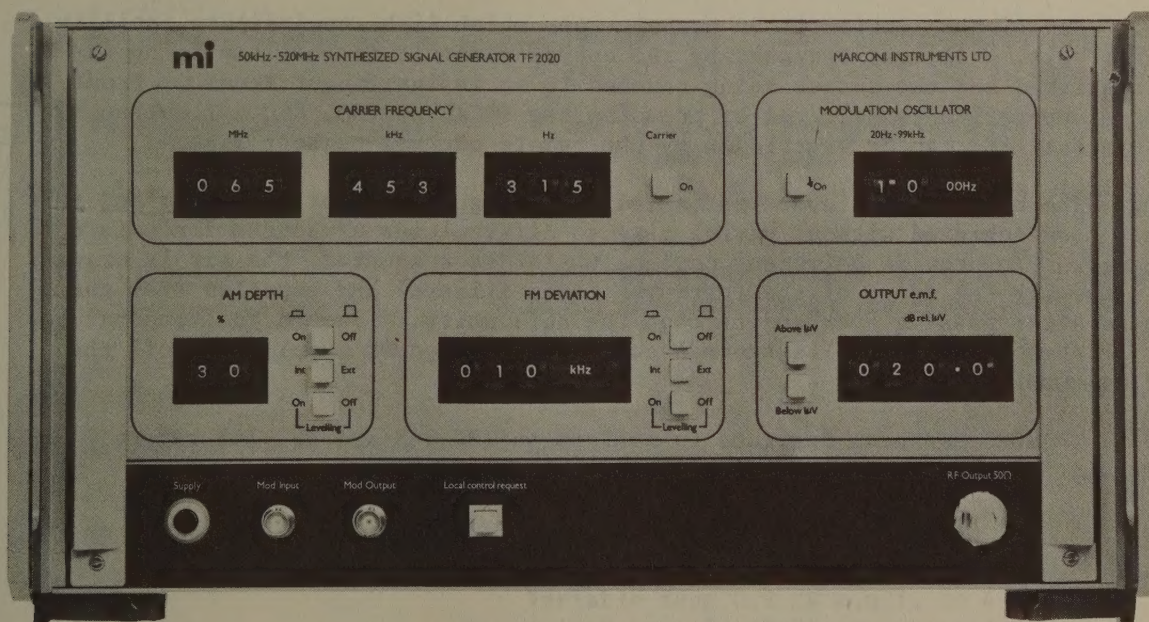


Fig. 1 50 kHz to 520 MHz Synthesized Signal Generator TF 2020

2. The carrier frequency can be set in increments of 1 Hz over the range 50 kHz to 520 MHz; either set locally on front panel thumbwheel type switches or remotely by b.c.d. program instructions. Settling time, after frequency change, is short : less than 10 ms is required to settle within 500 Hz of the required final frequency and 50 ms to settle within 1 Hz. The carrier is derived by synthesis from a 5 MHz standard oscillator giving a frequency stability, after 24 hours, of better than ± 1 in 10^8 per day. The internal standard can be adjusted against an external primary standard by means of a ten turn control with logging scale. The instrument may also be used on an external standard of 10 MHz or sub-multiples down to 1 MHz.

3. High quality frequency and amplitude modulation are provided from either the internal oscillator or an external modulating source. Both functions are completely independent allowing simultaneous f.m. and a.m. The internal modulation oscillator operates from 20 Hz to 99 kHz. Its output provides a low distortion signal, for audio frequency tests, of better than 0.1% distortion from 100 Hz to 99 kHz.

4. In addition to the full range of f.m. and a.m. facilities the TF 2020 provides an output voltage of 4 V down to 0.2 μ V e.m.f. from a 50 Ω source in the f.m. and c.w. modes of operation (2 V e.m.f. max. for a.m.). Despite this high output r.f. leakage has been kept to a minimum, allowing the generator to be used at the minimum output of 0.2 μ V e.m.f. without ambiguity. Non-harmonically related signals are at least 90 dB below the carrier level for frequencies above 120 MHz. At 20 kHz offset the sideband noise of the TF 2020 is at least 130 dB/1 Hz below the carrier level making it an ideal instrument for use as an off-channel signal generator in two-generator selectivity measurements (see Fig. 2).

5. Provision is made for automatic levelling in both f.m. and a.m. modes. Levelling may be selected on the front panel or via remote program instructions. Levelling OFF allows for remote analogue control of f.m. deviation or a.m. depth.

6. Function selection is by push-buttons which light to indicate facility available. Illegal requests by the operator result in the lamp being extinguished and the output being reduced to an insignificant level. Front panel operation is selected by pressing the LOCAL CONTROL REQUEST button but this facility can be overridden by the remote control request line.

7. The high output level has called for a high degree of screening and this has been achieved without giving rise to difficulties of access for maintenance. To provide efficient cooling whilst rack mounted, the air is drawn in through the front of the instrument (via filters) and expelled from the rear after passing over and through the r.f. units. Should the temperature rise above a safe level a thermal cut-out in the power supply cuts off the d.c. supplies.

8. TF 2020 has been designed to conform to IEC 348 and BS 4743 safety regulations.

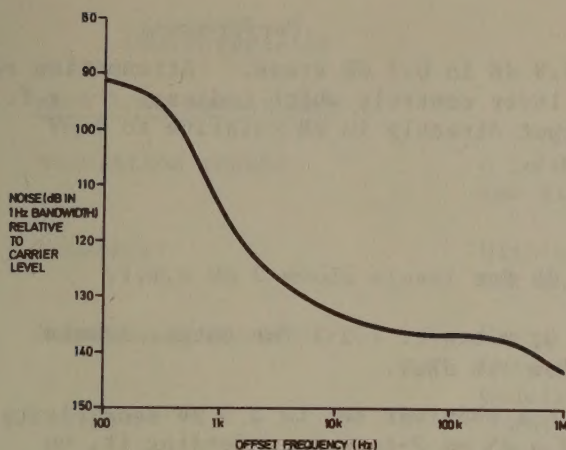


Fig. 2 Typical s.s.b. noise performance of TF 2020

PERFORMANCE DATA

Characteristic

Performance

9. Carrier frequency

Range:

50 kHz to 519.999999 MHz in 1 Hz increments.
Manual selection of frequency by 9 lever switch decade controls.

Stability
(internal standard):

+1 in 10^7 per month ageing rate.
+1 in 10^8 per day short term stability after 24 hours operation.

Stability
(external standard):

The system may be locked to any sub-multiple of 10 MHz down to 1 MHz.

Accuracy
(internal standard):

Adjustable by 10 turn control with logging scale on rear panel (see Chap. 3, para. 20).

Switching time:

After 10 ms the frequency is within 500 Hz of the final frequency, after 20 ms it is within 30 Hz and after 50 ms it is within 1 Hz.

Microphony:

Less than 20 Hz peak deviation is caused by 0.5 g acceleration in the range of 10 Hz to 100 Hz.

Load reaction:

None.

Attenuator reaction:

None.

10. RF output

Level:

Variable from 0.2 μ V e.m.f. to 4 V e.m.f. (-13.9 to +132 dB μ V) in c.w. and f.m. modes. For a.m. the maximum output level is 2 V e.m.f. (+126.0 dB μ V).

*Characteristic**Performance*

Attenuator:	145.9 dB in 0.1 dB steps. Attenuation set by lever controls which indicate the r.f. output directly in dB relative to 1 μ V e.m.f.
Total level accuracy (including a.l.c. loop and attenuator):	± 1 dB for levels above 2 μ V e.m.f.
Impedance:	50 Ω , v.s.w.r. 1.2:1 for output levels below 116 dB μ V.
Spurious r.f. radiation:	With a receiver set to 0.5 μ V sensitivity and a 25 mm 2-turn loop feeding it, no signal can be detected at a distance greater than 25 mm from the generator. Allows the 0.2 μ V minimum output level to be used without ambiguity.

11. Frequency modulation

Peak deviation:	Up to 299 kHz deviation may be set digitally with a 3 digit lever switch and thumbwheel range switch.
Deviation ranges:	0 to 2.99 kHz in 10 Hz steps, 0 to 29.9 kHz in 100 Hz steps, 0 to 299 kHz in 1 kHz steps. Maximum available deviation rises linearly from 50 kHz at a modulation rate of 50 Hz, to 299 kHz at 300 Hz, and falls linearly from 299 kHz at 33 kHz modulation to 100 kHz deviation at 100 kHz rate.
Deviation accuracy:	Better than $\pm 5\%$ of setting at 1 kHz modulation frequency.
Demodulation distortion:	Less than 2% total harmonic distortion at maximum deviation and less than 1% total harmonic distortion at 25 kHz deviation with 1 kHz modulation frequency (internal).
Response:	Relative to the deviation at 1 kHz modulation rate the variation over the modulation frequency range 50 Hz to 100 kHz is less than $\pm 10\%$.
External input:	<i>Levelling on</i> : datum level automatically set with a modulation input signal between 0.8 and 1.2 V. <i>Levelling off</i> : calibrated with 1 V r.m.s. sine wave input. <i>Input impedance</i> : 600 Ω .

Characteristic

Performance

12. Amplitude modulation

Modulation depth:	0 to 99% in 1% steps set digitally with a two digit lever switch.
Accuracy:	Within $\pm 5\%$ modulation depth at 1 kHz up to 80% indicated modulation depth.
Envelope distortion:	Using internal modulation oscillator:- Less than 2% t.h.d. with 30% depth at 1 kHz modulation frequency. With 80% depth and 1 kHz modulation frequency, less than 3% t.h.d. at carrier frequencies below 200 MHz and up to 5% t.h.d. up to 520 MHz.
Response:	Relative to the modulation depth at 1 kHz the variation over the modulation frequency range 20 Hz to 20 kHz is less than $\pm 10\%$.
External input:	<i>Levelling on</i> : datum level automatically set with a modulation input signal between 0.8 V and 1.2 V. <i>Levelling off</i> : calibrated with 1 V r.m.s. sinewave input at 1 kHz. <i>Input impedance</i> : 600 Ω .

13. Internal modulation oscillator

Frequency range:	20 Hz to 99 kHz. Adjustable by two digit lever switches and thumbwheel range switch. Four ranges: 20 Hz to 99 Hz in 1 Hz steps, 20 Hz to 990 Hz in 10 Hz steps, 100 Hz to 9900 Hz in 100 Hz steps, 1 kHz to 99 kHz in 1 kHz steps.
Frequency accuracy:	$\pm 5\%$ of setting.
Distortion:	Less than 0.1% t.h.d. from 100 Hz to 99 kHz. Less than 0.3% t.h.d. from 20 Hz to 100 Hz.
Output level:	Available from a front panel BNC socket at a fixed level of 1 V e.m.f. $\pm 20\%$ from a 600 Ω source. (The rack mounting kit includes a rear panel output socket.)

14. Spurious signals

Carrier harmonics:	At least 30 dB below fundamental at levels up to ± 126 dB μ V.
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Characteristic

Performance

Non-harmonically related coherent components:	All signals at least 90 dB below carrier level for carriers above 120 MHz; 80 dB below carrier level for carrier frequencies below 120 MHz and levels up to +126 dB μ V.
Single sideband phase noise:	At least 130 dB/Hz below carrier level at 20 kHz offset.
FM on c.w.:	With a post detection 3 dB bandwidth of 30 Hz to 15 kHz the equivalent deviation is less than 2 Hz.
AM on c.w.:	At least 75 dB below carrier level when measured in a 50 Hz to 20 kHz ($\sim$ 3 dB) post detection bandwidth. (Equivalent to less than 0.04% a.m.)
AM on f.m.:	Less than 2% modulation depth at maximum deviation. Less than 1% modulation depth at 25 kHz deviation.
Ph.m. on a.m.:	Less than 50 Hz equivalent at 30% modulation depth at 1 kHz modulation frequency (equivalent to less than 0.05 radian).

15. Auxiliary facilities

Remote operation:	Carrier frequency	Carrier on/off
	dB μ V output	Above/below 1 μ V
	FM on/off	FM int/ext
	FM levelling on/off	FM deviation
	AM on/off	AM int/ext. source
	AM levelling on/off	AM depth
	Modulation oscillator on/off	
	Modulation oscillator frequency	
	Local control request on/off	
	Remote control operation	

The remote facilities can be programmed using open collector logic or switch closures. The frequency Output Level, FM deviation, AM depth, Mod Oscillator frequency are programmed by universal b.c.d. logic. A logic '0' state is established by connecting a line to ground via 400 Ω at 2.4 mA except for the local control lock-out which is set to logic '0' by connecting 200 Ω to ground at 2.4 mA.

Outputs:	<i>Internal 1 MHz standard</i> signal is available on the rear panel at a level of 1.5 V p-p e.m.f. from 250 source.
	<i>Internal modulation oscillator</i> signal available on the front panel at a level of 1 V e.m.f. $\pm$ 20% from 600 Ω source.

Characteristic

Performance

Inputs:

External standard signal may be fed into the generator at any sub-multiple of 10 MHz down to a minimum frequency of 1 MHz at a level of 100 mV r.m.s. into 50 Ω . Maximum input signal 1.5 V.

External modulation signal between 0.8 V and 1.2 V across 600 Ω will automatically be set to the required datum level with the levelling on. 1 V r.m.s. sine wave input is required to achieve calibrated modulation with the levelling off.

16. General data

Safety regulations:

This instrument complies with IEC 348 and BS 4743 safety requirements.

Limit range of operation:

0 to 55°C.

Conditions of storage and transport:

Temperature : -40°C to +70°C.
Humidity : Up to 90% relative humidity.
Altitude : Up to 2500 m (pressurised freight of 27 kPa differential i.e. 3.9 lbf/in²).

Power requirements:

AC supply : 95 V to 130 V or 190 V to 264 V, 45 to 65 Hz, 180 VA approx.

Dimensions and weight :

Height : 234 mm (9 $\frac{1}{4}$ in).
Width : 450 mm (17 $\frac{3}{4}$ in).
Depth : 610 mm (24 in).
Weight : 38.5 kg (85 lb).

ACCESSORIES

17. Supplied accessories

Code No.

AC supply lead

43129-071D

RF Connecting Cable TM 4824/1; 50 Ω , 1370 mm (54 in), type N

43125-019F

18. Optional accessories

104-way free socket (with pins); to mate with REMOTE CONTROL INPUT plug

54712-031V

Adapter; type N male to BNC female

23443-804G

RF Connecting Cable TM 4969/3; 50 Ω , 1.5 m (5 ft), BNC

43126-012S

Matching Pad TM 5573/3; 50 Ω to 75 Ω , BNC

44411-019G

RF Fuse Unit TM 5753; 0.4 W, type N; complete with 10 spare fuses

43281-001W

7-pin free plug; to mate with DC OUTPUT socket

23435-007H

20 dB Pad TM 5573; 50 Ω BNC

44425-501E

20 dB, 20 W pad; 50 Ω , BNC

54431-021B

Rack mounting kit

46883-315Y

MI code

Maintenance kit comprising:-	54711-031Z
Extender board, short (Qty. 2)	44827-377M
Extender board, long (Qty. 2)	44827-356E
Extender guide, left (Qty. 1)	41700-132J
Extender guide, right (Qty. 1)	41700-131L
Coaxial extender lead (6 required)	43129-178C
Support, left, for A & B decks	35901-650P
Support, right, for A & B decks	35901-651X
Support, left, for C & D decks	35901-652M
Support, right, for C & D decks	35901-653C
Miniature telephone plugs, for testing unit AD40, (Qty. 2)	23421-610M
Adapter BNC to CONHEX screw-on jack	54311-041E
Trimming tool, straight	22951-221Y
Trimming tool, angled	41700-157U
Board extractor	41700-048A
Special spanner - for removing r.f. boxes and coaxial cable bosses.	34900-349P
Service manual (Vol. 2)	46881-309Y

Chapter 2

INSTALLATION

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- 1 Unpacking and repacking
- 3 Mounting arrangements
- 5 Connecting to supply
- 7 Fuses
- 8 Safety testing

UNPACKING AND REPACKING

1. Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument.
2. If the instrument is to be returned for servicing attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the general instructions below or with the more detailed information in the packing instruction note.
 - (1) Place the plywood/felt cap (without finger holes) in the bottom of the inner (fibreboard) carton.
 - (2) Lower the instrument into the carton with the feet facing the cut-outs in the bottom cap surround.
 - (3) Place the top plywood/felt cap (with finger holes) in position, with the cut-outs facing the feet.
 - (4) Fold down and seal the inner carton with tape.
 - (5) Fit the foam cushion pads in the outer (wooden) case.
 - (6) Wrap the instruction manual and accessories in a padded parcel and lay it in the bottom of the case.
 - (7) Lower the packed inner carton into the outer case and fold over the cushion pads to obtain a snug fit.
 - (8) Fit the top lid and secure with wood screws.
 - (9) Mark the case FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel controls with a plywood or cardboard load spreader; if the rear panel has guard plates or other projections a rear load spreader is also advisable.

MOUNTING ARRANGEMENTS

3. If a plastic cover is fitted over the instrument this must be removed to prevent overheating. Then position the instrument so that the rear outlet for the cooling fan is not obstructed.

4. The instrument may be mounted in a standard 19 inch rack using the kit 46883-315Y available as an optional accessory. When rack mounted the outer case must be left on to ensure efficient cooling, and the rear of the instrument supported.

CONNECTING TO SUPPLY

5. Before connecting the instrument to the a.c. supply check the position of the voltage selector on the rear panel. The instrument is normally despatched with the selector set to 230 V. For supplies in the range 95 to 130 V, remove the locking plate, set the switch to 110 V, reverse the plate and refit. Note that the a.c. supply fuses must also be changed - see para. 7.

6. The free a.c. supply cable is fitted at one end with a female plug which mates with the a.c. connector at the rear of the instrument. When fitting a supply plug ensure that conductors are connected as follows:

Earth	-	Green/Yellow
Neutral	-	Blue
Live	-	Brown

FUSES

7. The instrument is normally supplied with two 1 A fuses in the a.c. supply lines for supply voltages within the range 190 V to 264 V. For voltages in the range 95 to 130 V change the fuses for ones rated at 2 A. The fuses are 20 mm x 5 mm cartridge slow-blow (time lag) type.

SAFETY TESTING

8. Where safety tests on the mains input circuit are required, the following procedures can be applied. These comply with BS 4743 and IEC Publication 348. Tests are to be carried out as follows and in the order given, under ambient conditions, to ensure that mains input circuit components and wiring (including earthing) are safe.

(1) Earth lead continuity test from any part of the metal frame to the bared end of the flexible lead for the earth pin of the user's mains plug. Preferably a heavy current (about 25 A) should be applied for not more than 5 seconds.

Test limit : not greater than 0.5 Ω .

(2) 500 V d.c. insulation test from the mains circuit to earth and other circuits.

Test limit : not less than 2 M Ω .

Chapter 3

OPERATION

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PRINCIPLES OF CONTROL

1. The operating functions of the generator are controlled by passive logic, that is each function is called by an external short circuit to earth. The required earth connections are made either by local switching at the front panel or by remote switching from a control unit or computer. If an illegal operating condition is selected, either by local or remote control, for example a frequency outside the specified range, the button lamp concerned will go out and the output will be suppressed.

Push button control

2. All push button switches are of the push-push type, depressed to engage and pressed again to release, with the exception of the attenuator ABOVE 1 μ V

and BELOW 1 μ V switches. These two are interconnected with a rocking action. Pressing one releases the other and vice versa. All push buttons are illuminated when the switch is engaged, but in certain cases the lamp goes out if an illegal command situation occurs. No lamps are illuminated if the necessary conditions for local control are absent (see LOCAL CONTROL REQUEST below). The supply switch is of the ON/NOT ON type to give a clear indication that the instrument is switched off.

CONTROLS AND CONNECTORS

3. Coaxial connectors

The RF OUTPUT connector is N type whilst the remainder are BNC. Holes are provided on the rear panel to accommodate connectors when rack mounted.

4. Front panel

(1) LOCAL CONTROL REQUEST button : Selects manual control provided it is not over-riden by the manual lock-out line of the remote control input. If the manual lock-out connection is made this button has no effect and its lamp, and that of all other control buttons, is unlit.

(2) SUPPLY switch : Applies the a.c. supply voltage in both manual and remote control operation.

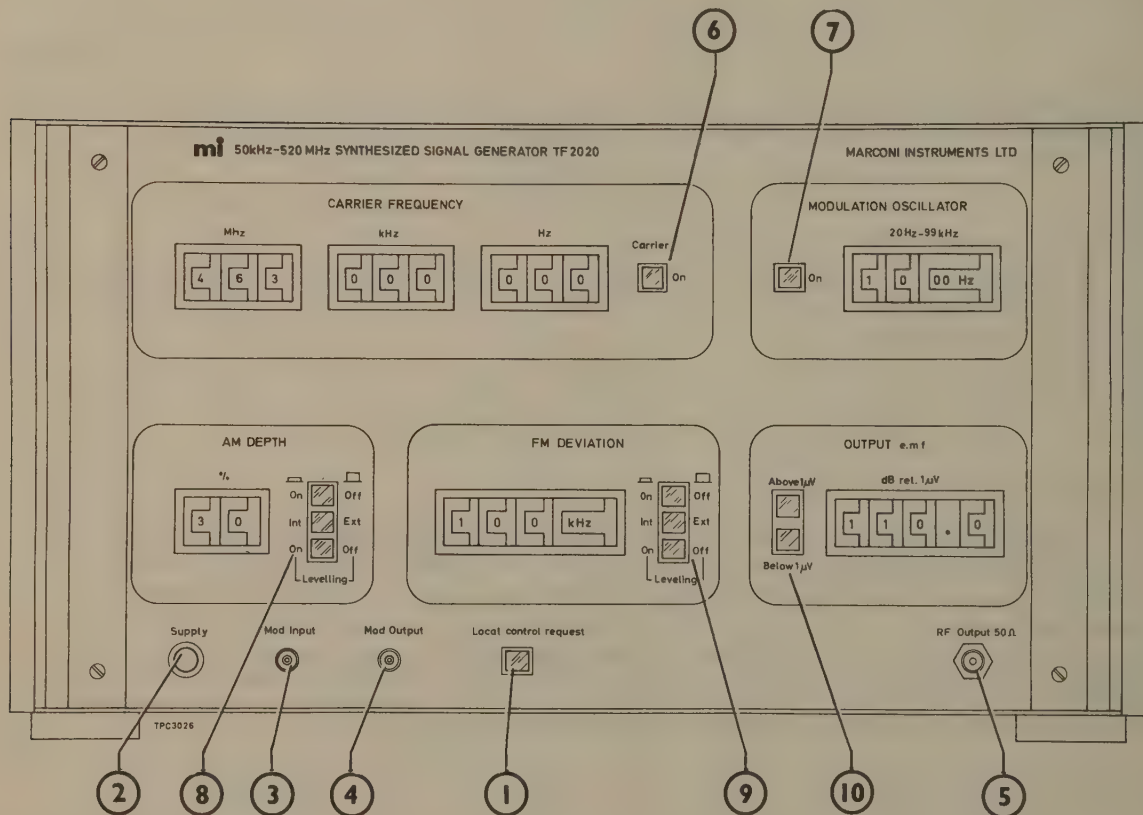


Fig. 1 Front panel

- (3) MOD INPUT socket : Accepts external modulating signals from 20 Hz to 100 kHz.
- (4) MOD OUTPUT socket : Provides an output of 1 V e.m.f. $\pm 20\%$ from a 600 Ω source at the frequency of the internal modulation oscillator.
- (5) RF OUTPUT socket : The output at this socket is shown by the setting of the OUTPUT EMF switches.
- (6) CARRIER FREQUENCY controls : With the CARRIER ON button depressed, the decade switches cover a range of 50 kHz to 519.999999 MHz in 1 Hz steps. Lamp goes out if a higher frequency is dialled.
- (7) MODULATION OSCILLATOR : With the ON button depressed, the decade switches cover 20 Hz to 99 kHz in four ranges. The output is available for internal a.m. and/or f.m. and also appears at the MOD OUTPUT socket.
- (8) AM DEPTH : With the ON button depressed, amplitude modulation is applied from the internal modulation oscillator when switched to INT or from the MOD INPUT socket when switched to EXT. Decade switches cover 0 to 99% modulation depth in steps of 1%. LEVELLING ON button selects automatic levelling in the EXTERNAL mode only. Levelling is provided in the INTERNAL mode regardless of button selection.
- (9) FM DEVIATION : With the ON button depressed, frequency modulation is applied from the internal modulation oscillator when switched to INT or from the MOD INPUT socket when switched to EXT. Decade switches cover 0 to 299 kHz in three ranges. Operation of the LEVELLING button is similar to para. 7 (8).
- (10) OUTPUT EMF controls : With the ABOVE 1 μ V button depressed, decade switches provide outputs in 0.1 dB steps from 0 dB μ V to +126 dB μ V (1 μ V to 2 V) in c.w., f.m. or a.m. modes or up to 132 dB μ V (4 V) in c.w. and f.m. modes only. With the BELOW 1 μ V button depressed, decade switches provide outputs from -13.9 dB μ V to 0 dB μ V (0.2 μ V to 2 μ V). The selected lamp goes out if the output is outside limits.

5. Rear panel

- (1) AC 45-65 Hz plug : Accepts mains input cable code no. 43129-071D. The earth pin is internally connected to chassis.
- (2) FUSES : 1 A for 190 V to 264 V supplies or 2 A for 95 V to 130 V supplies, slow-blow.
- (3) AC SUPPLY selector : Set to suit local supply voltage in ranges 95 V to 130 V or 190 V to 264 V.
- (4) MOD INPUT }
(5) MOD OUTPUT } : Internal connection to these sockets, instead of the corresponding front panel ones, can be made when the instrument is rack mounted. The necessary connectors are obtained by transferring the ones on the front panel to the rear panel and fitting the blanking buttons into the front panel holes.
- (6) INT/EXT STANDARD switch : With the safety plate removed, set to accept either an external standard or to use the internal standard.

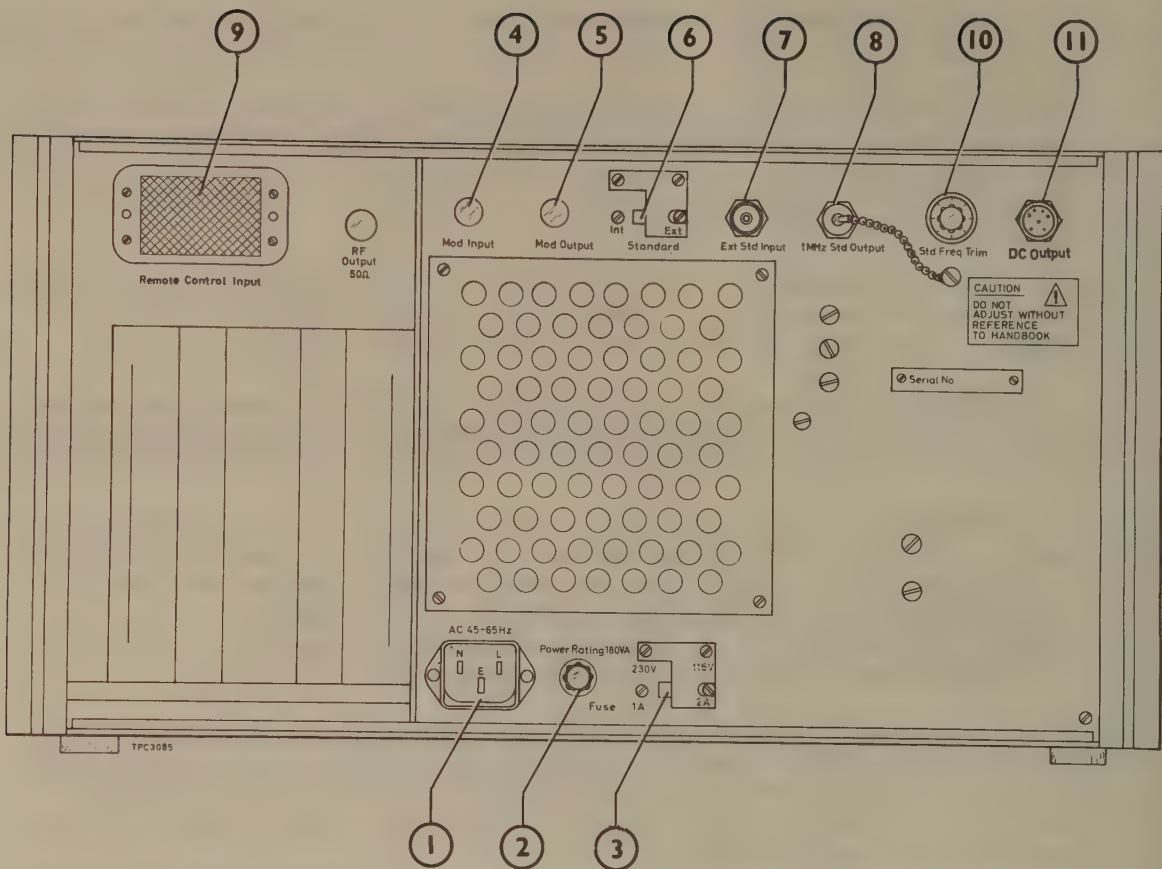


Fig. 2 Rear panel

(7) EXT STANDARD INPUT socket : For connection of a 100 mV external standard frequency signal.

(8) STANDARD OUTPUT socket : Provides a signal whose frequency is equal to the standard being used in the instrument. On internal standard the output frequency is 1 MHz.

(9) REMOTE CONTROL INPUT plug : Accepts 104-way socket with 89 remote control b.c.d. lines - see Fig. 3.

(10) STANDARD FREQ TRIM : Adjusted to set internal 5 MHz standard against an external primary standard. Refer to para. 23 before making any adjustments.

(11) DC OUTPUT : Provides +7.5 V, +22.5 V and -22.5 V to supply ancillary test equipment or programming apparatus with a load limitation of 100 mA per output (total load limitation of 2.5 W).

PREPARATION FOR USE

Switching on

6. With the instrument connected to a suitable a.c. supply proceed as follows.

(1) Switch on and check that the SUPPLY switch is lit and the fan is operating.

Note ...

If the power supply is overloaded an automatic cut-out operates. This will cause all button lamps to go out but, provided the mains fuse is still intact, the cooling fan will continue to run. To restore the supply, switch off, wait for at least 30 seconds and then press the SUPPLY button. If the button lamps stay out check the instrument for a fault condition.

(2) Check that the rear STANDARD INT/EXT switch is set to INT, unless an external standard is being used as described in para. 18.

(3) Allow a stabilizing period of approximately ten minutes before using the instrument. This gives a carrier frequency stability of about 1 part in 10^7 .

(4) The full rated short term stability of 1 part in 10^8 can be obtained by allowing a stabilizing period of 24 hours. For maximum accuracy the STANDARD FREQ TRIM control can be used to set the internal frequency standard against a primary standard as described in para. 18.

Manual operation

7. With the LOCAL CONTROL REQUEST button pressed and lit, all functions of the instrument can be set by the manual controls. However, it should be noted that a manual lock-out line allows the programming equipment to override the manual controls at any time. This programmable override causes the LOCAL CONTROL REQUEST button to be unlit.

Programmable operation

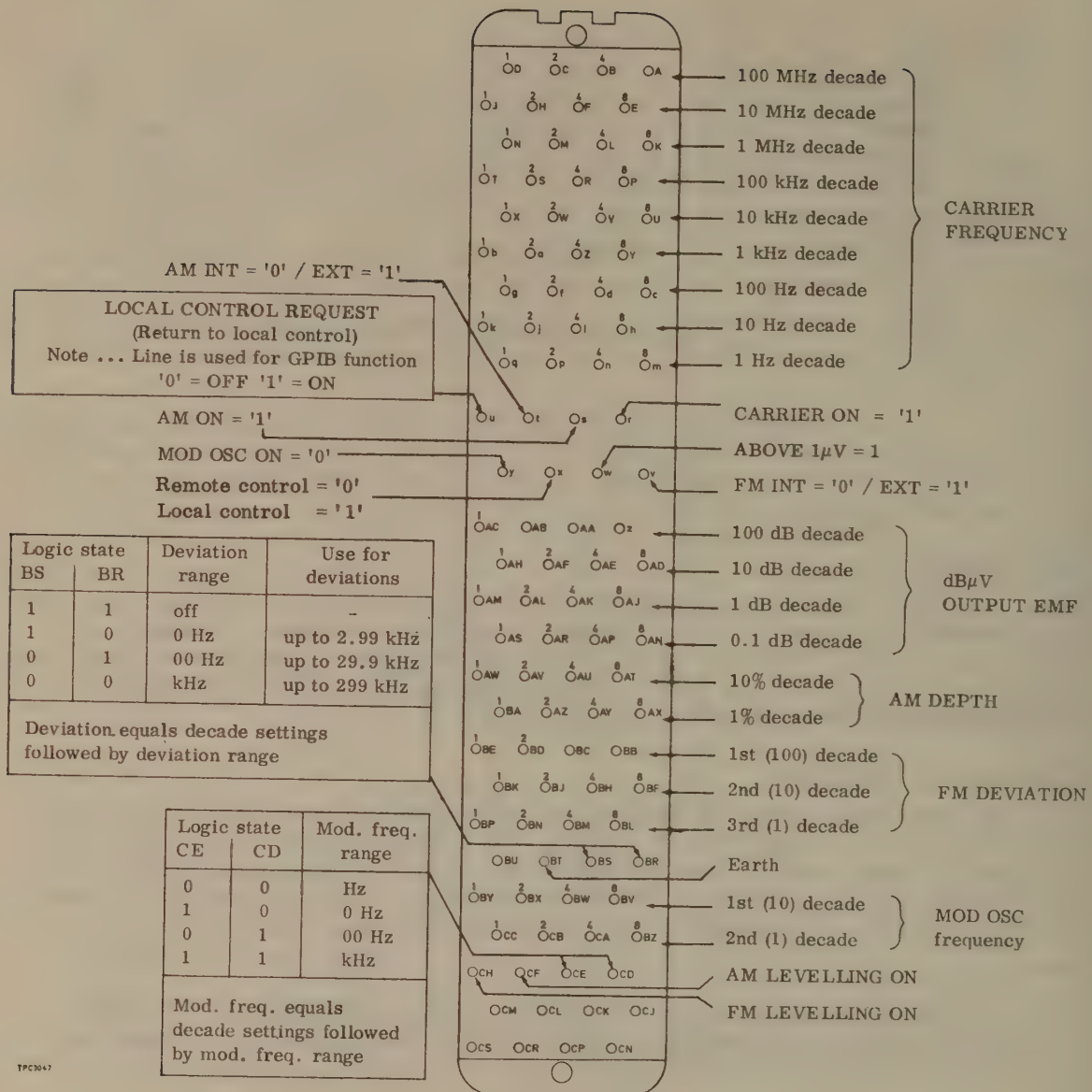
8. The functions listed in Table 1 are selected by application of parallel entry b.c.d. data to the REMOTE CONTROL INPUT connector PLA as shown in Fig.3. The control logic used is passive negative, that is each line is held in the 'off' state, unless otherwise indicated, by an internal 5 V pull-up voltage and is called by an applied short circuit to earth.

Note...

An instruction on pin x takes priority over the setting of the LOCAL CONTROL REQUEST button and forces local or remote operation depending upon the logic level applied.

TABLE 1 PROGRAMMABLE FUNCTIONS

<i>Control function</i>	<i>Number of lines</i>
Carrier on/off	1
Carrier frequency	35
Modulation oscillator on/off	1
Modulation oscillator frequency	10
Amplitude modulation on/off	1
AM depth	8
FM on/off and ranges 1-2-3	2
FM deviation	10
AM and f.m. levelling	2
Int/ext modulation a.m.	1
Int/ext modulation f.m.	1
Output above and below 1 μ V	1
Output level	13
Remote/local control	1
Local control request	1
Earth	1



NOTE : '1' state = open circuit, '0' state = short circuit to earth
(Function is called by '0' state unless otherwise indicated)

Fig. 3 Program control : mating socket to PLA
viewed from rear (wired side) of socket

TABLE 2 EXAMPLE OF PROGRAMMING

To call function:-	Apply '0' (short circuit) to pin nos:-
Supply on	Not programmable - press SUPPLY switch
Carrier frequency : 123.45 MHz	D H M N R V X
Mod. oscillator on : 400 Hz	y BW CD
Int. a.m. on : 30% depth	t AW AV
Ext. f.m. on : 25 kHz deviation	BD BH BK BS
+60 dBμV output	AE AF
Remote control operation	x

NOTE. When using remote control facility other than TK 2021, wire a link between pin x and u to permit the use of the Local control request button.

OPERATING PROCEDURES

9. Unless otherwise stated the procedures given in the following sections are applicable to both manual and programmable control.

Setting carrier frequency

10. Select CARRIER ON and set the required carrier frequency within the range 50 kHz to 519.999999 MHz.

Setting r.f. output

11. The setting of the OUTPUT attenuator controls indicates the level of output in dB relative to 1 μ V e.m.f. To convert into direct units of voltage see Fig. 4.

Outputs from -13.9 dB μ V (0.2 μ V) to 0 dB μ V (1 μ V)

(1) Select OUTPUT : BELOW 1 μ V and set the attenuator controls as required.

Outputs from 0 dB μ V (1 μ V) to 126 dB μ V (2 V)

(2) Select OUTPUT : ABOVE 1 μ V and set the attenuator controls as required.

Outputs from 126 dB μ V (2 V) to 132 dB μ V (4 V)

(3) This higher output level range is only available for c.w. or f.m. operation and not for a.m. operation.



Fig. 4 Conversion scale : dB μ V to voltage units

Setting internal a.m.

12. To set the internal a.m. proceed as follows:-

(1) Select MODULATION OSCILLATOR : ON and set to the required modulating frequency.

(2) Select AM DEPTH : ON, INT and set to the required % depth of modulation.

13. The output of the modulation oscillator is also available at the MOD OUTPUT socket, at a level of 1 V e.m.f. from a 600 Ω source, for external use with auxiliary equipment.

Setting internal f.m.

14. To set the internal f.m. proceed as follows:-

(1) Select MODULATION OSCILLATOR : ON and set to the required modulating frequency.

(2) Select FM DEVIATION : ON, INT and set to the required frequency of deviation. Note that there are three deviation ranges:-

0 to 299 0 Hz in 10 Hz steps

0 to 299 00 Hz in 100 Hz steps

0 to 299 kHz in 1 kHz steps

15. The output of the modulation oscillator is also available at the MOD OUTPUT socket, at a level of 1 V e.m.f. from a 600 Ω source, for external use with auxiliary equipment.

Use of external modulation

16. An external modulating source must be capable of providing a signal between 0.8 and 1.2 V across 600 Ω within the range 50 Hz to 100 kHz for f.m. or 20 Hz to 20 kHz for a.m.

(1) Connect the modulating signal to the MOD. INPUT socket on the front panel (or on the rear panel if the instrument has been modified for this purpose).

(2) Select AM DEPTH : ON, EXT or FM DEVIATION : ON, EXT as required and set the % depth or deviation as for internal modulation.

(3) Set the LEVELLING button to ON.

Use of mixed a.m. and f.m.

17. AM and f.m. can be applied simultaneously in any of the following combinations:-

- (i) both from the internal modulation oscillator,
- (ii) both from the same external modulating source,
- (iii) one internal and the other external.

In each case, follow the appropriate individual modulation procedures given in paras. 12 to 14.

Use of external frequency standard

18. The generator may be controlled from an external frequency standard, in place of the internal one, for system synchronizing purposes or where an exceptional degree of accuracy or stability is required. The standard signal may be at any sub-multiple of 10 MHz down to 1 MHz at a level of 100 mV into 50 Ω (maximum input level 1.5 V).

19. To use this facility remove the locking plate, set the STANDARD INT/EXT switch to EXT and connect the signal to the EXT STANDARD INPUT socket. Refit the locking plate. Allow a few seconds for the internal locking circuit to stabilize.

Adjustment of internal frequency standard

20. The STANDARD FREQ TRIM preset on the rear panel enables the internal standard to be set against a primary external standard and for logging its degree of drift. The output of the internal standard is available for this purpose at the 1 MHz STANDARD OUTPUT socket.

CAUTION ...

Incorrect adjustment of this preset will impair the frequency accuracy of the generator.

21. The external standard, which must have an accuracy of 5 parts in 10^8 or better, may take the form of a standard frequency transmission such as MSF, Rugby, used in conjunction with a v.l.f. comparator. Alternatively a rubidium or caesium reference unit can be used.

22. Alternatively the 1 MHz internal standard output can be measured on a counter which is controlled by a local frequency standard. To obtain the necessary resolution, a gate time of at least 100 seconds is required unless an error multiplication system is available which will reduce the gate time to a more convenient figure.

23. The STANDARD FREQUENCY TRIM control¹ is a 10-turn potentiometer with an adjustment range of about 2 parts in 10^7 per turn. It is advisable to keep a note of the settings of the logging scale before and after adjustment. In this way, if periodic resettings are made, the ageing characteristic of the internal standard can be established.

OUTPUT IMPEDANCE MATCHING

24. In the normal case of a matching $50\ \Omega$ resistive load the voltage developed across the load is 6 dB less than the e.m.f. indicated by the setting of the OUTPUT attenuator (or half the equivalent level in voltage units given by the conversion scale in Fig. 4).

25. To match a load greater than $50\ \Omega$ to the output of the generator a resistor R_s must be connected in series with the generator output. The value of R_s is given by the difference between the load resistor, R_L , and the generator source resistance of $50\ \Omega$, that is $R_s = R_L - 50\ \Omega$. The voltage across the load matched in this way is then equal to half the voltage equivalent of the indicated dB μ V. No correction factors need be applied to the dB μ V e.m.f. scale readings.

26. When a series resistor is used for matching a load, the output impedance of the generator will be mismatched. It is preferable therefore to use the optional 20 dB pad TM 5573 between the generator and the series resistor if the additional loss can be tolerated. In this way, both generator and load will be correctly matched.

27. For the particular case of a $75\ \Omega$ load, a 50 to $75\ \Omega$ Matching Pad TM 5573/3 is available as an optional accessory. This comprises an asymmetric T-pad so that both generator and load are correctly matched. It reduces the effective e.m.f. of the generator by 6 dB and produces a voltage across the load equal to one quarter of the voltage equivalent of the indicated dB μ V.

OUTPUT PROTECTION

28. When using the instrument for testing transceivers it is recommended that either the 20 W/20 dB pad or RF Fuse Unit TM 5753 be used to ensure protection of the TF 2020 attenuator resistors should the transceiver be accidentally switched to the transmit mode. Both these items are available as optional accessories - see Chap. 1.

Chapter 4-1

BRIEF TECHNICAL DESCRIPTION

CONTENTS

Para.

- 1 Introduction
- 2 Circuit summary

Fig.

1	Block diagram	...	...	...	...	...	...	...	Page
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INTRODUCTION

1. The following summary is an outline circuit description of the instrument and is intended to be read in conjunction with the block diagram. Detailed descriptions of each stage are given in Chap. 4-2.

CIRCUIT SUMMARY

Frequency generation

2. The output frequency is derived from a single fixed frequency crystal via a combination of phase locked loops. The final output frequency in the range 50 kHz to 520 MHz is generated by the u.h.f. loop. This oscillator is phase locked by frequencies from the $n \times 10$ MHz loop and the 20-30 MHz synthesizer. These oscillators are in turn locked to the primary standard. The final output frequency is split into two ranges, 50 kHz to 120 MHz and 120 MHz to 520 MHz. The lower range is derived by mixing a signal in the range 400.050 MHz to 519.999999 MHz produced by the u.h.f. loop with a fixed 400 MHz signal.

Primary standard

3. 10 MHz standard and 10 MHz comb outputs are derived from either the internal crystal controlled 5 MHz source or any external standard which is a sub-multiple (down to 1 MHz) of 10 MHz. Adjustment is provided to enable the internal standard to be calibrated against an external standard.

400 MHz loop

4. The 400 MHz loop utilizes the primary standard 10 MHz comb output to lock a 400 MHz oscillator. The 400 MHz output is fed to the l.f. channel for mixing with the 400.05 to 520 MHz part of the high frequency range to produce the lower frequency range of 50 kHz to 120 MHz.

n x 10 MHz loop

5. 100 and 10 MHz outputs from this loop are also locked to the primary standard by use of the 10 MHz comb. One of the six oscillators is switched and steered towards the selected multiple and finally locked by the comb. The switching and steering are controlled by frequency selection logic.

20-30 MHz synthesizer

6. The synthesizer uses three phase locked loops to generate frequencies in the range 20 to 29.999 in 1 Hz steps. A 10 MHz output from the primary standard ensures phase lock. FM drive from the modulation process circuits is applied to the output oscillator.

UHF loop

7. The 120 to 520 MHz output in 1 Hz steps is provided by six oscillators. The selected range oscillator is switched and steered by signals from the frequency selection circuits. This oscillator is phase locked by the resultant of two 20-30 MHz signals. One signal is the 20-30 MHz synthesizer output, the other a mixer output which is fed with u.h.f. and n x 10 MHz loop outputs.

HF channel

8. These circuits handle the higher frequency range outputs of 120 to 520 MHz. In these circuits the signal is amplitude modulated and levels corrected prior to passing on to the output processing.

LF BFO channel

9. The output from the HF channel provides 120 to 520 MHz output when passed direct to the output processing but for the lower frequency range part of its output is fed via the l.f. b.f.o. channel. In the l.f. channel it is mixed with 400 MHz from the 400 MHz loop. ALC circuitry provides levelling in both high and low frequency modes of operation.

Output processing

10. The output from the generator is amplified to 4 V e.m.f. (in c.w. and f.m. modes, 2 V e.m.f. for a.m.). This output is controlled by attenuator circuits to give selected level outputs of between 0.2 μ V e.m.f. and 4 V e.m.f. in 0.1 dB μ V steps. The amount of attenuation is dialled up on the front panel or selected by a programmed source.

Modulation processing

11. The a.m. and f.m. drive to modulators in the h.f. channel and 20 to 30 MHz synthesizer may be derived from either internal or external oscillators. Mode selection and internal frequency selection is front panel dialled or externally programmed.

Frequency selection

12. Programmed or manually selected information is processed by logic boards to switch on the appropriate oscillators and steer them to their approximate frequency. These boards also ensure that the channel amplifiers are changed for the two frequency ranges and that the received instructions are valid.

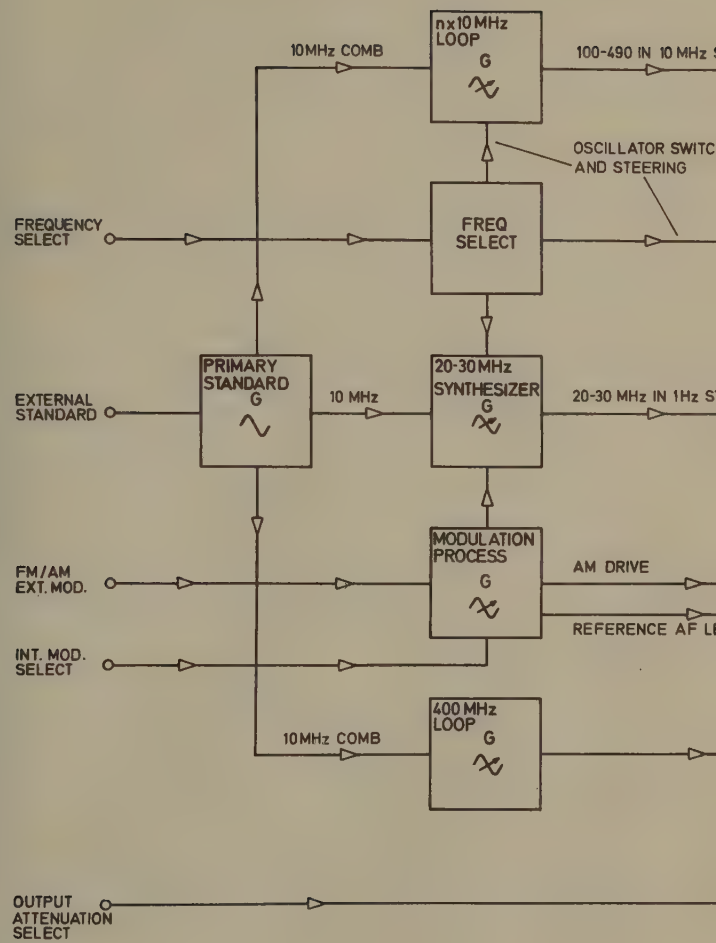
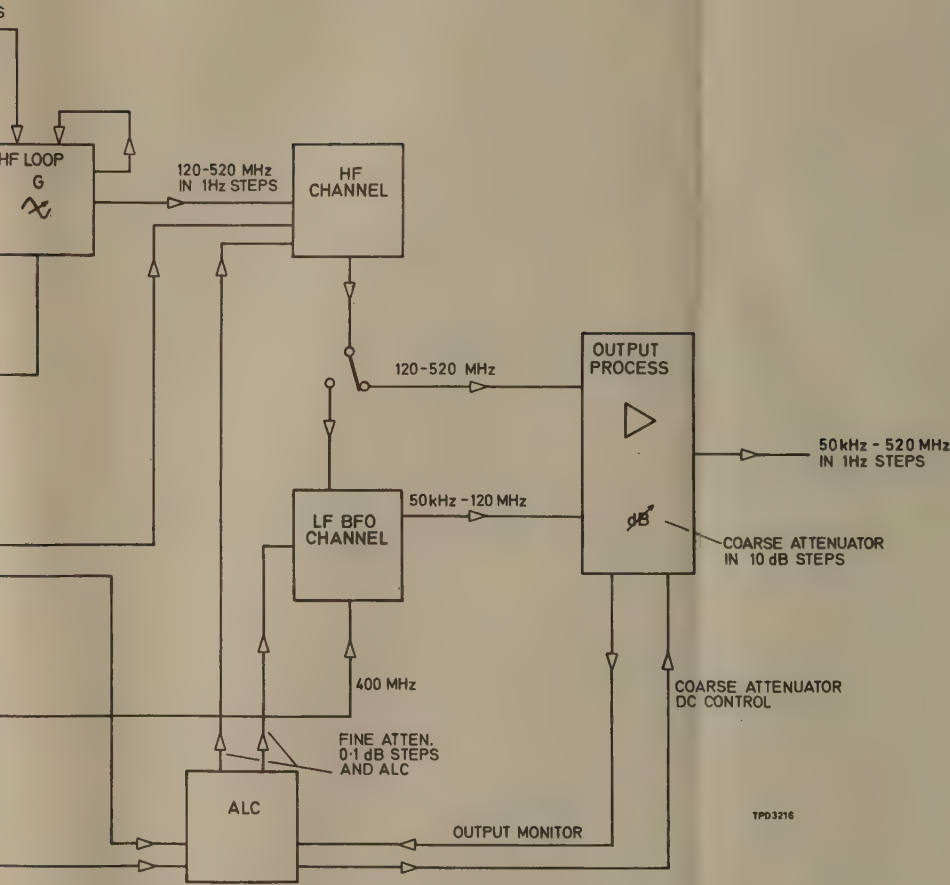


Fig. 1

Block



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